

Purpose: Students will investigate the properties of water and how surfactants disrupt the surface tension of water. Additionally, students will explore the impact of agriculture based products in food.

Time: 60 minutes

Level: 5, 6

Materials:

- Pennies
- Pipettes/medicine droppers
- Plastic cups
- Pepper
- Milk
- Food coloring
- Lecithin (granular; found in the health food section of the grocery store)
- Baking cocoa
- NesQuik

Glossary

Lecithin – fatty substance found in some animal and plant tissues

Surface Tension – the cohesive forces among liquid molecules that form a surface “film” which allows it to resist external force.

Surfactant – substance that adjusts the surface properties and surface tension, of the liquid or solid to which it is applied. Emulsifiers, detergents, foam inhibitors and wetting agents are examples of surfactants.



On the Surface with Food Science

Minnesota Science Standards and Benchmarks

- 5.1.1.1.4 Understand that different models can be used to represent natural phenomena and these models have limitations about what they can explain.
- 5.1.1.2.2 Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify variables in a scientific investigation.
- 6.2.1.2.1 Identify evidence of physical changes, including changing phase or shape and dissolving in other materials.

Background

Abundant, affordable, vast variety-it's the American way when it comes to food. U.S. consumers have the safest, least expensive food in the world. We spend just 10% of our disposable income for food compared to Italy where they pay 14%, China where it's 33% and Pakistan 46%. Along with the low cost of food, there are new products every year, offering more convenience, longer shelf life, better nutrition, new flavors and sometimes a whole new idea that no has invented before. This abundance comes from agriculture – farmers who produce a bounty of food and also food scientists and researchers who utilize the raw products and their chemistry to offer new food options for consumers.

The lesson focuses on the function of surfactants, specifically soy leithitin, to influence food composition. This is just one example of a scientific discovery by food scientist and chemists that impacted the products available in grocery stores.

Procedure

Penny Predications

1. Divide students into teams of 2-3. Give each team 1 penny, 1 medicine dropper, 1 cup of water
2. Ask students to predict how many drops of water can fit on their penny. Record this prediction on the Penny Predictions section of the Observation Sheet.
3. Instruct the students to use the medicine dropper to add drops of water, one at a time, on the top of the penny. Count each drop until the water leaks off the side.
4. Have each team repeat this process 3 times, making sure to record the number of drops for each test on their Observation Sheet.
5. Instruct students to complete the Penny Predictions section on the Observation Sheet, making sure to compare their actual test results

with their predictions and draw 2 different angles of the water on the penny. Also, answer the questions.

6. Discuss with students their observations. Ask students to explain why they think water formed a dome on the penny.

Lead discussion to inform students about cohesion. Water molecules are cohesive which means that stick together. Why they stick together they form a “skin” or “film”. Because of this an insect can stand on the surface of a pond and you can get lots of drops on the top of a penny.

Attractive Molecules

1. Give each team an empty plastic cup, 1 medicine dropper and 2 toothpicks.
2. Instruct each team to turn their plastic cup upside down and place it on their desk/table.
3. Each team must use the medicine dropper to place two drops of water on the bottom of the cup about 1 inch apart.
4. Use the toothpicks to move one drop of water over to the other drop to make one big drop of water. How easy was that? Have students record their observations on the Attractive Molecules section of the Observation Sheet.
5. Use the toothpicks to separate the big drop into two smaller drops. How easy was that? Record on observation sheet.
6. Ask students to think about why one action was harder than the other. Hint: think back to the Penny Predictions.

Water cohesion causes the process of combining two drops much easier than pulling one big drop apart.

The Pepper Dance

1. Give each team 1 small plate, 1 glass of water, and a pinch of pepper.
2. Instruct students to fill the plate with water.
3. Sprinkle the pepper evenly on the surface of the water.
4. Using a soap bottle/dispenser (this will most likely be shared between teams) squirt one drop into the middle of the pepper on the surface of the water.
5. Record observations on The Pepper Dance section of the Observation Sheet.
6. Assist students in thinking about why the pepper moved. Introduce the term surfactant and instruct students to record its definition on their observation sheet.

Surfactant – substance that adjusts the surface properties and surface tension of a liquid or solid to which it is applied. The term surfactant is made up from letters of the words “surface active agent.”

The soap is a surfactant and causes water molecules that are cohesive to move apart. By watching the pepper, you can see the water molecules move.

Color Swirls

1. Facilitate a brainstorm session where students think of examples of surfactants and where they are used.
2. Read the Background Information worksheet about the surfactant lecithin. Students can read on their own, as a team or as a whole class. Inform students that you are going to observe the action of lecithin from soybeans.

3. Give each team 1 small plate, 1 small cup of milk and ½ tsp of lecithin.
4. Pour the milk on the small plate. Place three equally spaced drops of food coloring (most likely food coloring will be shared between groups) in the milk.
5. Inform students that they are going to add lecithin, a surfactant to the milk. Ask students to record their prediction of what is going to happen in the Color Swirls Section of their Observation Sheet.
6. Have students sprinkle a few granules of the lecithin on the drops of color. Record their observations in the Observation Sheet.
7. Discuss what happened with the students.

Soy lecithin is a surfactant much like soap. When added to the food coloring and milk it causes the water molecules to separate and move. The food coloring shows how they move. Why do the molecules move more slowly in milk than they did in water (dancing pepper?) Milk has more fat and less water molecules – the molecules move more slowly because of the fat.

Why is NesQuik Quick?

1. Give each team 2 empty plastic cups, water, ½ tsp baking cocoa, ½ tsp NesQuik.
2. Turn both cups upside down and set on desk/table.
3. Place a large drop of water on the top of each cup.
4. Sprinkle the cocoa on one water drop. Observe what happens and describe this on the Why is NesQuik Quick? section of the Observation Sheet.
5. Sprinkle the NesQuik on the other drop. Observe what happens and describe this on the Why is NesQuik Quick? Section of the Observation Sheet.
6. Have students compare the ingredient labels from NesQuik and baking cocoa. Use this information to explain why the baking cocoa and NesQuik mixed with the water differently on the Observation sheet.

NesQuik has soy lecithin that causes the water molecules to separate and breaks the surface tension. The water molecules spread out and the NesQuik chocolate goes into the water drop. The cocoa does not contain soy lecithin so it sits on the top of the water drop. The cocoa does not break the surface tension or cause the water molecules to separate.

Additional Activities

- Explore Food-A-Pedia for quick facts about more than 8,000 foods: <https://www.supertracker.usda.gov/default.aspx>
- Explore Foods related to Food Science and chemistry at: <http://www.agriculture.purdue.edu/USDA/careers/foodscientist.html>

Adapted from 4-H AgriScience Curriculum, Robert L. Horton PhD Ohio State University Extension.

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On the Surface with Food Science

Observation Sheet

Name _____

Chemistry and biotechnology are used to make foods healthier and move continent. Be a food chemist and discover how surface tension, surfactants and soybeans are used to make NesQuik so quick.

Penny Predictions

How many drops of water fit on the penny?	
Prediction:	
Test 1:	
Test 2:	
Test 3:	
Average for all 3 tests	
Difference between prediction and the average:	

1. Draw what the penny looked like with the water on top. Draw two different angles.

Angle 1

Angle 2

2. Explain why the water looked like this on the penny.

Attractive Molecules

1. Was it easy or difficult to put the drops together? Circle how you would rate this process on the scale below.

1	2	3	4	5
Very Easy				Very Difficult

2. Was it easy or difficult to separate the big drop into two smaller drops? Circle how you would rate this process on the scale below.

1	2	3	4	5
Very Easy				Very Difficult

3. Explain why one action was harder than the other.

Dancing Pepper

Draw your observation of the pepper on the surface of the water BEFORE you added the soap.	Draw your observation of the pepper on the surface of the water AFTER you added the soap.

1. What is a surfactant?

Color Swirls

1. What do you think will happen when you add the soy lecithin (a surfactant) to the food coloring in the milk? Write your prediction.
2. Was your predication correct? Explain why or why not.

Why is NesQuik quick?

1. Describe what happens when baking cocoa is sprinkled on a large drop of water.
2. Describe what happens when NesQuik is sprinkled on a large drop of water.
3. Compare the ingredient labels for NesQuik and baking cocoa. Use this information to explain your observations from questions 1 and 2.

Background Information

What is lecithin and what can it do?

Lecithin

Lecithin is an oily substance found in some plants (soybeans) and animals (egg yolks). After soybeans are harvested, they are cleaned, cracked and de-hulled. The soybean oil is separated from the soybean meal. Soy lecithin can be mechanically or chemically removed from the soybean oil.

Lecithin in food technology

Soy lecithin is a versatile tool in food technology. Lecithin does not dissolve easily in water, which results in its surfactant qualities. Lecithin is sometimes sold as a food supplement. In cooking, it is used as an emulsifier. Lecithin is also used to prevent sticking in non-stick cooking spray.

Lecithin also acts as an emulsifier, or mixing agent. When used as an ingredient it helps fat and water stay mixed. As an emulsifier, lecithin improves the smoothness and creaminess of chocolate. That is important in both the manufacturing process and the shelf life of the chocolate.



Lecithin in other products

The unique properties of lecithin make it useful in pharmaceutical and cosmetic applications as well as many industrial products. Lecithin is used as an ingredient in crayons, sunscreen, lip balm, the protective coating on CDs, inks, paints, textiles, lubricants and waxes. Soy lecithin is even used in today's oil fields, as a "green option" reducing friction in drill bit lubrication and to achieve viscosity requirements in fresh, saltwater and other drilling muds.



Soybeans, just before harvest



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